EFFECTS OF SAMPLING METHOD ON COMPOSITION OF A TASMANIAN COASTAL HEATHLAND SPIDER ASSEMBLAGE

TRACEY B. CHURCHILL

Churchill, T.B. 1993 11 11: Effects of sampling method on composition of a Tasmanian coastal heathland spider assemblage. *Memoirs of the Queensland Museum* 33(2:): 475-481. Brisbane. ISSN 0079-8835.

The composition of a spider community in coastal heathlands of north-east Tasmania was derived from a 16 month survey using pitfall traps, sweep net and visual search sampling methods incorporated into a replicated, standardised sampling program. This interpretation of composition is shown to rely on the relative efficiency of the three collecting methods to sample the taxa present. Since mature spiders are required to confirm species identity, the differential selection of age and sex classes by the methods is illustrated. Whilst pitfall traps catch a greater number of taxa (at all taxonomic levels) and adult spiders, certain taxa are not or barely represented by this widely used technique. The subjective nature of the visual search method allows for the potential to target mature spiders. Limits of the sampling methods are emphasised in response to a growing dependence on survey data for the assessment of biodiversity.□*Araneae, methodology, biodiversity, heathland, invertebrates, community.*

Tracey B. Churchill, Division of Environmental Science, Griffith University, Nathan, Queensland 4111, Australia; 6 November, 1992.

Surveys of spider communities in Australia have primarily been motivated by specific taxonomic interests in this relatively unknown faunal group. Whilst this has lead to invaluable improvements in taxonomy, such collections are increasingly being utilised to extract data for the making of critical conservation management decisions. It is therefore necessary that further consideration be given to the factors that can affect the interpretation of survey results.

The primary factor that limits the comparability of data from different locations or times is the method used to sample spiders. Different methods can preferentially sample certain microhabitats and/or particular taxa (Merrett and Snazell, 1983). For example, the commonly used pitfall trap selects ground active species (Duffey, 1974; Merrett and Snazell, 1983; Lowrie, 1985) and the use of this method alone can produce species lists that under-represent more sedentary or foliage inhabiting members of the community.

The effectiveness of different sampling techniques can be influenced by behavioural differences between not only taxa, but also age or sex classes of a given species. For example, males of many species are more readily captured by pitfall traps than females due to their active search for a mate (Merrett, 1967, 1968), which may represent ground activity in an otherwise foliage dwelling taxa. Since mature specimens are usually required to identify species or genera, the ability to catch adults will effect the accuracy of a species list.

By adopting a suite of collecting techniques to target spiders both on the ground and in vegetation, the chances of sampling all taxa present are increased and thus data more useful for community studies are collected (Uetz and Unzicker, 1976). Accordingly, a combination of pitfall trap, sweep net and visual search methods was selected for a 16 month survey of spiders in the north-east coastal corner of Tasmania. The area is largely developed as sheep and cattle grazing properties, although to the seaward side of the remaining coastal *Eucalyptus* and *Casuarina* forests is often a margin of heathland dominated by members of the Proteaceae, Casuarinaceae, Epacridaceae, Papilionoideae and Xanthorrhoeaceae. An increasing impact of recreational and residential development threatens the remaining heathland (Kirkpatrick, 1977). In this paper, the composition of spiders in the heathland community is inferred by the list of spider taxa collected over the survey period. The relative efficiency of the three sampling methods in capturing dominant taxa is then compared to illustrate how the choice of method can influence the final interpretation of community composition or species richness.

MATERIALS AND METHODS

Spiders were collected using pitfall traps, sweep net and by visual searching, each of which was standardised for effort and replicated. At monthly intervals from October 1986 to January 1988, sampling was carried out during a one week field trip. Two replicate 90m^2 sites were selected at each of two study areas, Waterhouse Point and Eddystone Point. Within each site there were nine 18m^2 plots placed 18m apart in three rows of three. This allowed for three replicate plots per sampling method, allocated initially at random. For the relevant plot the following sampling routine was employed: a) Nine pitfall traps were set 4.5m apart in a 3 x 3 matrix using 9cm diameter traps; b) one sweep sample of 50 sweeps was taken using a 28cm diameter net in a 12 x 3 m area and c) visual searching for 30 minutes was made over a 3 x 3m area. Spiders were preserved in 70% alcohol, identified to species where possible, and lodged with the Queen Victoria Museum, Launceston, Tasmania.

The three sampling methods were considered to be complementary in their selection of taxa occupying different strata. Pitfall traps sample spiders mobile on the ground, in contrast to sweep netting which targets spiders in the foliage. Visual searching can reveal spiders in any microhabitat, but a bias was shown towards those secured within web retreats, as such groups may not be amenable to capture by the previous two methods.

RESULTS AND DISCUSSION

Composition

A total of 8,625 spiders were collected using all three methods over 16 months, and these spiders comprised 130 species of the Araneomorphae in 97 genera and 34 families (see Table 1). Names could not be allocated to 26% of genera and 92% of species, indicating further that many Australian groups need taxonomic revision (Davies, 1985; Raven, 1988). The most diverse families in terms of the number of species were the Salticidae (14 spp.) and Gnaphosidae (11), followed by the Theridiidae (9), Zodariidae (9), Thomisidae (8) and Araneidae (8). The four most abundant species were, in decreasing order Diaca sp. (5.8%), *Badumna vandiemani* (5.3%), *Odo* sp. (4.3%), *Hestimodema* sp. (4.1%).

The number of spiders falling into pitfall traps depends on their activity (Mitchell, 1963;

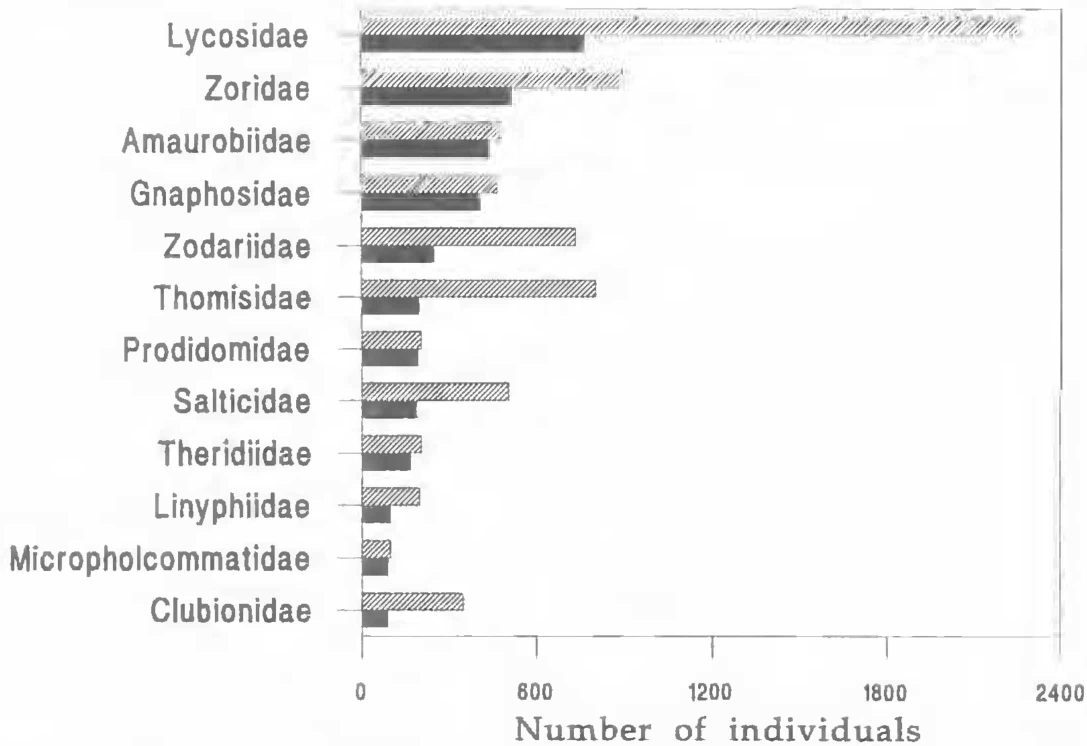

FIG. 1. Number of individuals (shaded bars) and adults (black bars) for the twelve dominant spider families.

Amaurobiidae
Genus A sp.1 *
Genus A sp.2 *
Genus B sp.
Genus C sp.
Genus D sp.

Amphinectidae
Amphinecta milvinus (Simon, 1903)
Mamoeo sp.

Araneidae
Cyclosa sp.
Eriophora biapicata (Koch, 1871)
Gasteracantha minax Thorell, 1859
Genus E sp.
Genus F sp.
Genus G sp.
Genus H sp.
Genus I sp.

Clubionidae
Cheiracanthium sp.
Clubiona sp. 1
Clubiona sp. 2
Clubiona sp. 3
Genus J sp.

Corinnidae
Asadipus sp.
Castianeira sp.
Supunna sp.

Cyatholipidae
Hanea sp
Matilda sp.

Desidae
Austmusia sp.
Badumna vandiemani Gray, 1983 *
Forsterina sp.
Tuakana sp.

Dictynidae
Callevophthalmus sp.1
Callevophthalmus sp.2

Gnaphosidae
Anzacia sp.1 *
Anzacia sp.2 *
Eilica sp. *
Megamyrmaekion sp.
Micaria sp.
Trachycosmus sp. *
Zelotes sp.1
Zelotes sp.2
Zelotes sp.3
Genus K sp.
Genus L sp.

Hadrotarsidae
Hadrotarsus sp.1
Hadrotarsus sp.2
Genus M sp.

Hahniidae
Neoaviola sp.

Heteropodidae
Neosparassus sp.

Linyphiidae
Laetesia sp.1 *
Laetesia sp.2
Laetesia sp.3
Laetesia sp.4
Genus N sp.
Genus O sp.

Lycosidae
Artoria sp.1 *
Artoria sp.2 *
Artoria sp.3
Artoria sp.4 *
Artoria spp.
Lycosa furesta (Koch, 1849)
Lycosa speciosa (Koch, 1879)
Lycosa sp.

Micropholcommatidae
Micropholcomma sp.1
Micropholcomma sp.2
Textricella sp.1
Textricella sp.2 *
Textricella sp.3

Mimetidae
Australomimetus sp.

Miturgidae
Miturga sp.1
Miturga sp.2
Uliodon velox (Hickman, 1930)
Uliodon sp.

Mysmenidae
Genus P sp.

Nicodamidae
Nicodamus melanozanthus (Urquhart, 1893)

Oecobiidae
Oecobius annulipes Lucas, 1846

Oonopidae
Orchestina sp.
Genus Q sp.

Oxyopidae
Genus R sp.

Pararchaeidae
Pararchaea sp.

Pisauridae
Dolomedes sp.

Prodidomidae
Molycria sp. *

Salticidae
Lycidas sp.
Marptus sp. *
Opisthoncus sp.
Pseudosynagelides sp.
Servaea sp.
Genus S sp.1
Genus S sp.2
Genus S sp.3
Genus S sp.4
Genus T sp.
Genus U sp.
Genus V sp.
Genus W sp.
Genus X sp.

Stiphidiidae
Baiami sp.
Corasoides australis Butler, 1929
Stiphidion facetum Simon, 1902

Tetragnathidae
Deliochus sp.
Phonognatha sp.
Tetragnatha sp.

Theridiidae
Achaearanea sp.
Dipoena sp.
Episinus sp.
Euryopis sp.
Phoroncidia trituberculata (Hickman, 1951)
Steatoda sp.1
Steatoda sp.2
Steatoda livens (Simon, 1895)
Theridion sp. *

Thomisidae
Cymbacha sp. *.
Diaea sp. *
Sidymella sp.1
Sidymella sp.2
Sidymella sp.3
Sidymella sp.4
Sidymella longipes (Koch, 1874)
Stephanopis sp.

Toxopidae
Laestrygones setosa Hickman, 1969

Trochanteriidae
Corimaethes sp.

Zodariidae
Asteron sp. *
Asteron "reticulatum"
"*Australatica*" sp.
Habronestes sp.1
Habronestes sp.2
Habronestes "bradleyi"
Neostorena sp.1
Neostorena sp.2
Nostera sp.

Zoridae
Argoctenus sp.
Hestimodema sp. *
Odo sp. *
Thasyraea sp.

TABLE 1. List of spiders collected from Tasmanian coastal heathlands. Asterisk indicates the 20 most abundant species.

Greenslade, 1964; Uetz and Unzicker, 1976; Merrett, 1983) and not necessarily on actual abundance in the community (Merrett, 1967; Merrett and Snazell, 1983). Individuals active on foliage presumably experience a higher probability of being knocked into a sweep net and for the visual search method the chance of noticing spiders would be increased by their activity (Curtis, 1980). Therefore it is stressed that references to abundance in this paper relate to numbers caught and not population size.

With respect to the number of individuals, the collections were dominated by the Lycosidae (26% of the total), Zoridae (10%), Thomisidae (9%) and Zodariidae (9%) (Fig. 1). The families Salticidae, Amaurobiidae, Desidae and Gnaphosidae then account for the next 22%. With the exception of the zodariids and zorids, these families are amongst the largest in Australia (Raven, 1988). The Araneidae, which are otherwise the most abundant Australian spider family (Raven, 1988), comprised only a minor component of this collection (1.4%).

The dominance hierarchy (Fig. 1) is determined by the number of adults in each family. However, as it is not standardised as to whether the whole data set (including immatures) or only the adult data are used to describe patterns of family dominance in a given community, a comparison is made to both (Fig. 1). The interpretation of relative abundance of families is affected by which category is used. Given that only adult data are useful for comparisons at the generic or species level, adult data seem the better choice for assessments of biodiversity.

Effects of Sampling Method on Composition

Pitfall traps collected the most individuals (6212), followed by visual searching (1900) and sweep netting (513). However, as the sampling effort of pitfall traps far exceeds that of sweep netting and visual searching, comparisons of taxa between methods are made relative to the total of each method.

Due to a reliance on acquiring mature spiders from surveys to confirm species and generic level identifications, Fig. 2 presents the differential distribution of age and sex classes for each sampling method. Pitfall traps clearly caught the greatest percentage of males (35%) and visual searching, the least (3%). Females are also collected more by pitfall traps, although the difference between methods is not as distinct. Accordingly, the percentage of immature spiders increases from pitfall traps (46%), through sweep net (75%) to visual search (84%) methods. From these results pitfall traps seem to be the most efficient at selecting mature spiders from the coastal heathland community.

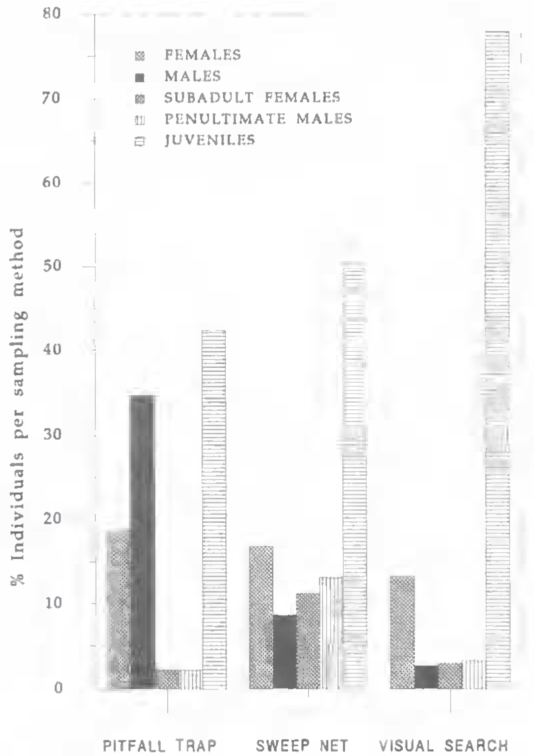

FIG. 2. Percentage of individuals in each sampling method for the different age and sex classes.

The total number of families, genera, and species can be compared to that collected by each sampling method (Table 2). At each taxonomic level, pitfall traps sample the most taxa (between 87-94% of the total), followed by visual searching (41-66%) and sweep netting (25-41%). It is relevant to point out that the results presented here were derived over a 16 month survey period. The likelihood of recording certain taxa using a given sampling method for typically shorter survey periods depends on the relative ease with which they are collected by that method (it also depends on the temporal abundance of taxa, to be discussed elsewhere). The percentage of adult

	Total	Pitfall	Sweep	Visual
Family	34	32	14	23
Genus	97	84	30	45
Species	130	113	33	53

TABLE 2. The number of taxa in total, and for each sampling method at three taxonomic levels.

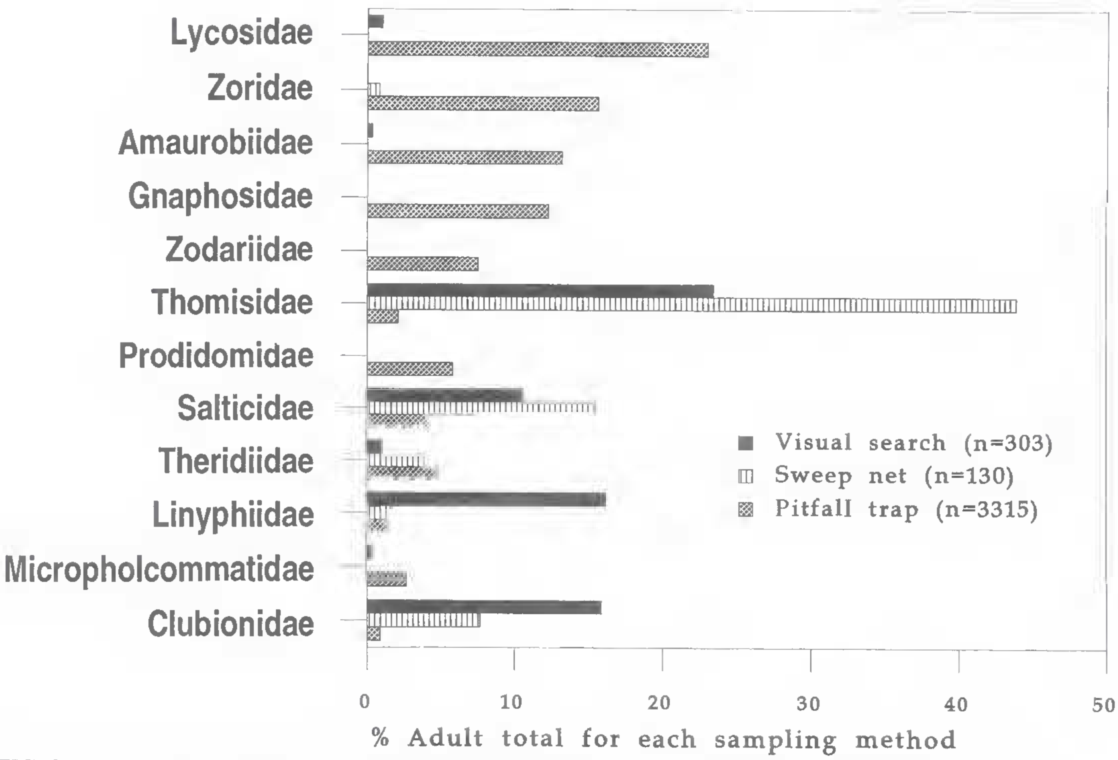

FIG. 3. Percentage of the adult spider total for each sampling method for the 12 dominant spider families.

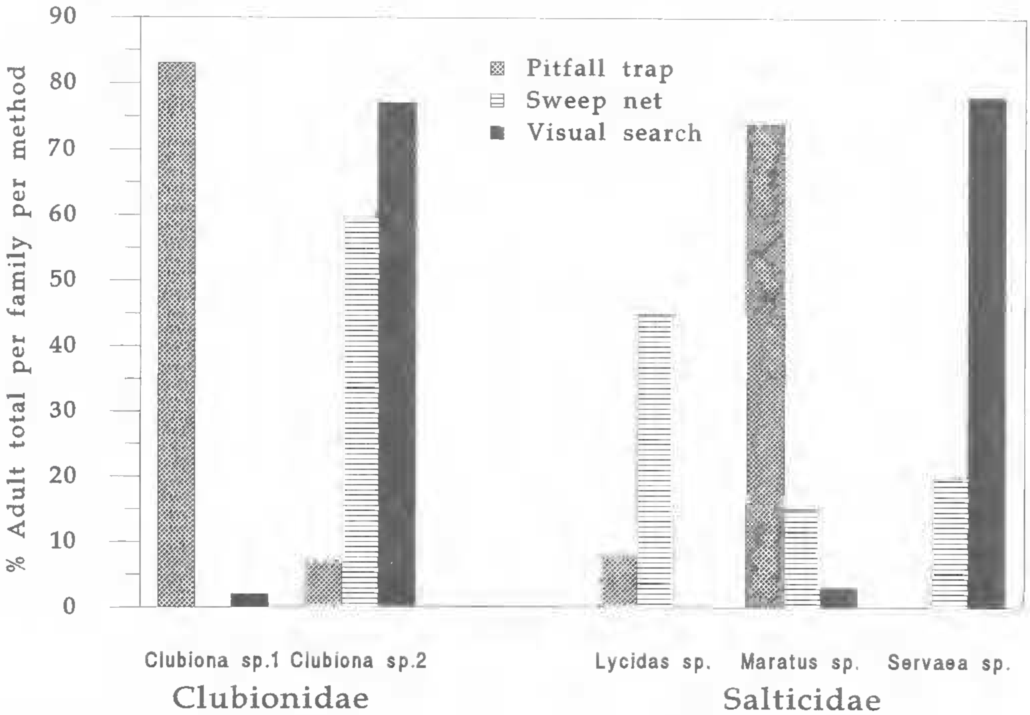

FIG. 4. Percentage of the adult spider total for each sampling method of Clubionidae and Salticidae.

spiders sampled by each method varies over the 12 dominant families (Fig. 3). Ground dwelling spiders such as gnaphosids or zodariids are exclusively caught by pitfall traps. Despite lycosids and zorids being sampled by all methods, there is a reduced chance that they would be represented by sweep net and visual searching over a shorter survey period. If only pitfall traps were used, the probability of representing the families Thomisidae or Salticidae is markedly reduced. Linyphiids, due to their habit of building low webs under the foliage are primarily amenable to capture by visual searching. Consequently, the results show that there is a greater probability of representing some families over others according to the method used.

The number of species in each family are distributed differently across sampling methods (Table 3). Whilst the ground dwelling spiders such as the gnaphosids and zorids have all their species falling into pitfall traps, other families have a pattern of species distribution across methods quite different to the distribution of individuals. For example, thomisids may be best sampled using sweep netting and visual searching (Fig. 3). Yet, these methods inadequately sample all the thomisid species collected (Table 3). The contrast is explained by the two most abundant thomisids, *Diaea* sp. and *Cymbacha* sp. being collected mostly by sweep net and visual search methods. Further examples include all clubionid species being sampled by all three methods (compared to a very unequal distribution of individuals) and a greater number of salticid species being sampled by pitfall traps (compared to this method catching the least number of salticids).

The number of individuals of the dominant

Family	Total	Pitfall trap	Sweep net	Visual
Amaurobiidae	5	5	0	1
Clubionidae	5	3	3	3
Gnaphosidae	11	11	0	0
Linyphiidae	6	6	1	6
Lycosidae	7	7	0	0
Micropholcommatidae	5	5	0	1
Prodidomidae	1	1	0	0
Salticidae	14	9	7	6
Theridiidae	9	6	2	3
Thomisidae	8	8	2	3
Zodariidae	9	9	0	0

TABLE 3. Number of species in total and for the three sampling methods for 12 dominant families.

species of clubionids and salticids illustrates that the differential selection of taxa by sampling method also operates at the species level (Fig. 4). Within the Clubionidae, despite the two species being collected by all three methods, *Clubiona* sp. 1 was almost exclusively sampled by pitfall traps, whereas *Clubiona* sp.2 was more often taken by a sweep net or visual searching. Similarly, the three dominant salticid species were preferentially sampled by the three different methods. Hence, if one sampling method was favoured over any other, especially for a shorter survey period, many species would be omitted from the final species list.

IMPLICATIONS FOR THE FUTURE SURVEY OF SPIDER COMMUNITIES

There is currently no spider sampling technique that is unbiased. The success of any method is usually related to certain aspects of spider behaviour and therefore generally represents an incomplete range of taxa. Whilst this may be readily acknowledged by arachnologists, the limitations of a given method is not always clarified in the interpretation of community composition. This is particularly important when non-arachnologists utilise the information as representative of the whole community.

Despite the use of three sampling methods in this survey, the species list is not unbiased. In this study, sweep net and visual search methods were carried out during the day and may therefore not select nocturnally active taxa. Visual searching included looking at the ground, but effective sampling of leaf litter was not undertaken, and this micro-habitat can harbour distinctive families (Raven, 1988). The visual search method is also subjective in terms of where the search focus is directed. Attention was paid in this survey to sample spiders in positions (particularly in nests) that were not as vulnerable to the other two collecting methods. Where the objective of the survey is to estimate taxonomic composition of the spider fauna, the efficiency of both the visual search and sweep net methods could be improved by avoiding the collection of distinctly immature spiders.

Also, the equipment design can effect the number of individuals and taxa caught (eg., for pitfall traps see Luff, 1975 and Curtis, 1980). Temporal factors can further influence which taxa are susceptible to capture by a given method and as discussed by Abraham (1983), this can be related to seasonal migration of spiders between vegetative strata. To enhance the comparability of survey data, there is therefore a need to standardise methodology, equipment design, sampling effort and timing. Yen and Butcher (1992) also make this plea in respect of terrestrial invertebrate surveys for the ultimate goal of conservation. Methodological limitations need to be taken into account during the final interpretation of taxonomic lists for a more useful assessment of the fauna. These aspects are stressed in the light of a rapidly growing reliance on such data sets for conservation and management in Australia, and the need to critically assess invertebrate survey methods for estimating the loss of biodiversity worldwide (Coddington *et al.*, 1991).

ACKNOWLEDGEMENTS

A survey of spiders of the north-east coastal heathland was supported by the Plomley Foundation at the Queen Victoria Museum, Launceston, Tasmania, who also funded curation of half of the spider collection. Specimens were identified and the curation completed with resources kindly provided by the Arachnology section, Queensland Museum (Brisbane) and with taxonomic advice from Mark Harvey (Nicodamidae), Rudy Jocqué (Zodariidae), Rolly Mackay (Lycosidae), Robert Raven (all other taxa) and Marek Zabka (Salticidae). Completion of the project has been possible through an Australian Postgraduate Research Award at Griffith University, Brisbane.

LITERATURE CITED

ABRAHAM.J. 1983. Spatial and temporal patterns in a sagebrush steppe spider community (Arachnida, Araneae). Journal of Arachnology 11: 31-50.

CODDINGTON, J.A., GRISWOLD, C.E., DAVILA, D.S., PENARANDA, E. & LARCHER, S.F. 1991. Designing and testing sampling protocols to estimate biodiversity in tropical ecosystems. Pp. 44-60. In Dudley, E.C. (ed.) 'The unity of evolutionary biology: proceedings of the fourth international congress of systematic and evolutionary biology'. (Dioscorides Press: Portland, Oregon).

CURTIS, D. 1980. Pitfalls in spider community studies (Arachnida, Araneae). Journal of Arachnology 8: 271-280.

DAVIES, V. TODD 1985. Araneomorphae (in part). Pp. 49-125. In Walton, D.W. (ed.) 'Zoological Catalogue of Australia. 3. Arachnida'. (Australian Government Printing Service: Canberra).

DUFFEY, E. 1974. Comparative sampling methods for grassland spiders. Bulletin of the British Arachnological Society 3: 34-37.

GREENSLADE, P.J.M. 1964. Pitfall trapping as a method for studying populations of Carabidae (Coleoptera). Journal of Animal Ecology 33: 301-310.

KIRKPATRICK, J.B. 1977. 'The Disappearing Heath'. (Tasmanian Conservation Trust Incorporated).

LOWRIE, D.C. 1985. Preliminary survey of wandering spiders of a mixed coniferous forest. Journal of Arachnology 13: 97-110.

LUFF, M.L. 1975. Some features influencing the efficiency of pitfall traps. Oecologia 19: 345-357

MERRETT, P. 1967. The phenology of spiders on heathland in Dorset: 1. Families Atypidae, Dysderidae, Gnaphosidae, Clubionidae, Thomisidae and Salticidae. Journal of Animal Ecology 36: 363-374.

1968. The phenology of spiders on heathland in Dorset: 1. Families Lycosidae, Pisauridae, Agelenidae, Mimetidae, Theridiidae, Tetragnathidae, Argiopidae. Journal of Zoology (London) 156: 239-256

1983. Spiders collected by pitfall trapping and vacuum sampling in four stands of Dorset heathland representing different growth phases of heather. Bulletin of the British Arachnological Society 6: 14-22

MERRETT, P. & SNAZELL, R. 1983. A comparison of pitfall trapping and vacuum sampling for assessing spider faunas on heathland at Ashdown Forest, south-east England. Bulletin of the British Arachnological Society 6: 1-13.

MITCHELL, B. 1963. Ecology of two carabid beetles, *Bembidion lampros* (Herbst) and *Trechus quadristriatus* (Schrank) II.Studies on populations of adults in the field with special reference to the technique of pitfall trapping. Journal of Animal Ecology 32: 377-392.

RAVEN, R.J. 1988. The current status of Australian spider systematics. Pp. 37-48. In, Austin, A.D. and Heather, N.W. (eds) 'Australian arachnology'. The Australian Entomological Society Miscellaneous Publication No. 5.

UETZ, G. E. & UNZICKER, J.D. 1976. Pitfall trapping in ecological studies of wandering spiders. Journal of Arachnology 3: 101-111.

YEN, A.L. & BUTCHER, R.J. 1992. Practical conservation of non-marine invertebrates. Search 23: 103-105.